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(54) **BIPOLAR FORCEPS HAVING MONOPOLAR EXTENSION**

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(75) Inventors: **Kate Lawes**, Lafayette, CO (US); **Sean T. Dycus**, Denver, CO (US); **Ned Cosgriff**, Denver, CO (US)

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(73) Assignee: **Sherwood Services AG**, Schaffhausen (CH)

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Primary Examiner—Michael Peffley
Assistant Examiner—Victoria W Chen

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(57) **ABSTRACT**

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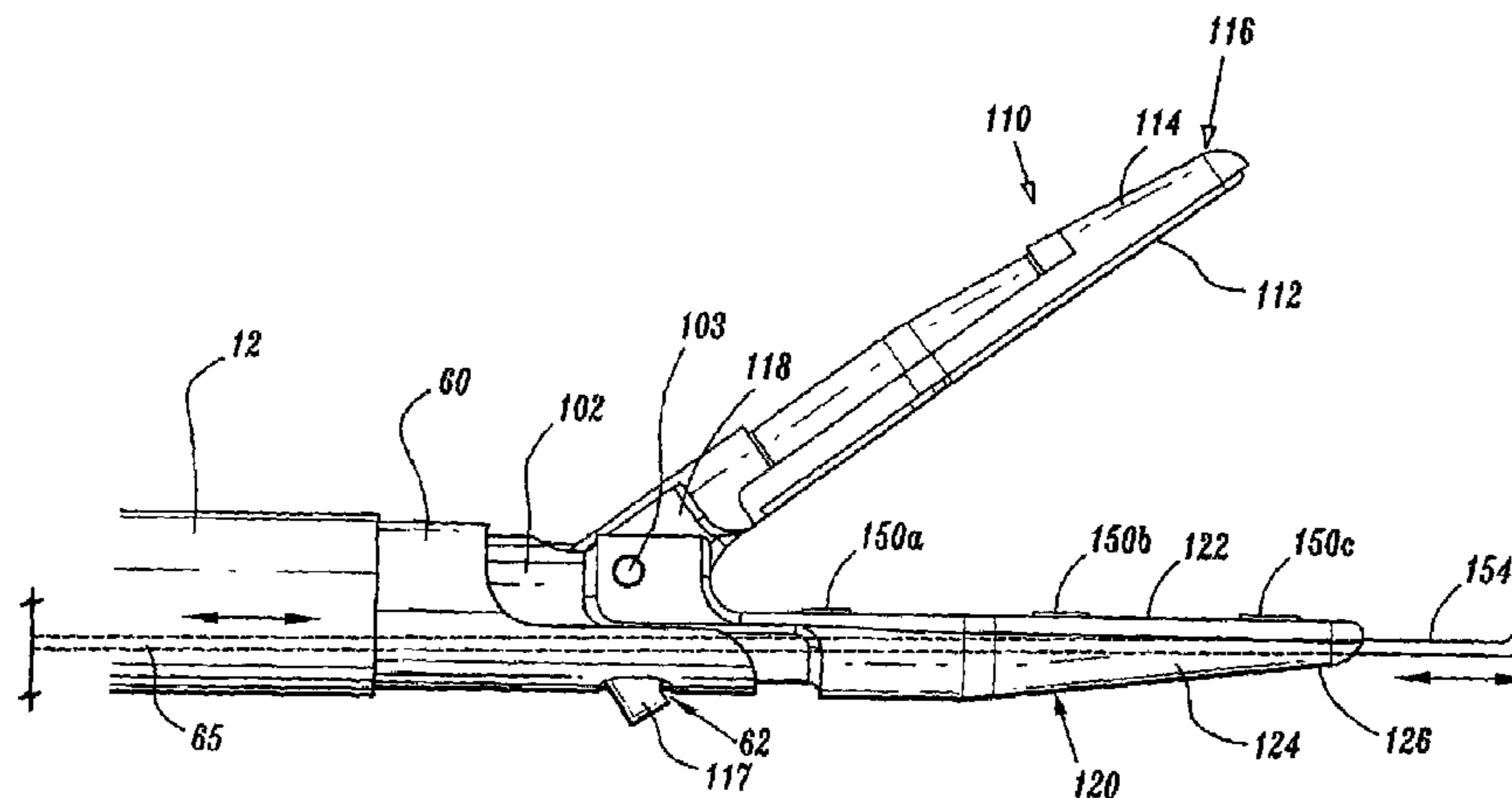
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See application file for complete search history.

An endoscopic forceps for treating tissue includes a housing having a shaft affixed thereto which has first and second jaw members attached to a distal end thereof. The forceps also includes an actuator for moving jaw members relative to one another from a first position wherein the jaw members are disposed in spaced relation relative to one another to a second position wherein the jaw members cooperate to grasp tissue therebetween. Each of the jaw members is connected to a source of electrosurgical energy such that the jaw members are selectively capable of operating in a bipolar mode which enables the jaw members to conduct bipolar energy through tissue held therebetween to treat tissue. The forceps also includes a monopolar element housed within the first jaw member which is selectively movable from a first position within the first jaw member to a second position distal to the first jaw member. The monopolar element is connected to the source of electrosurgical energy and is selectively activateable independent of the bipolar mode.

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13 Claims, 8 Drawing Sheets



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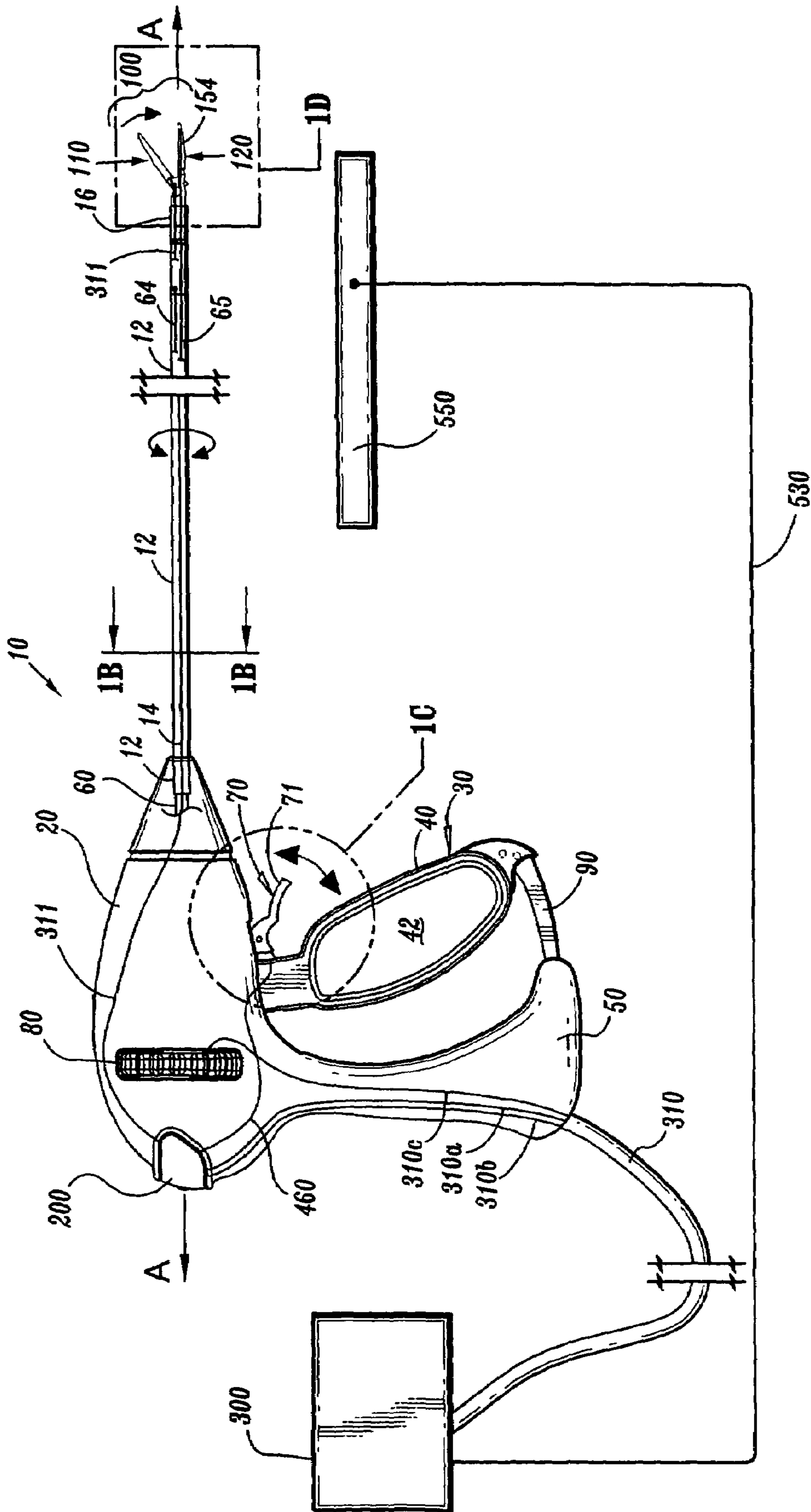


FIG. 1A

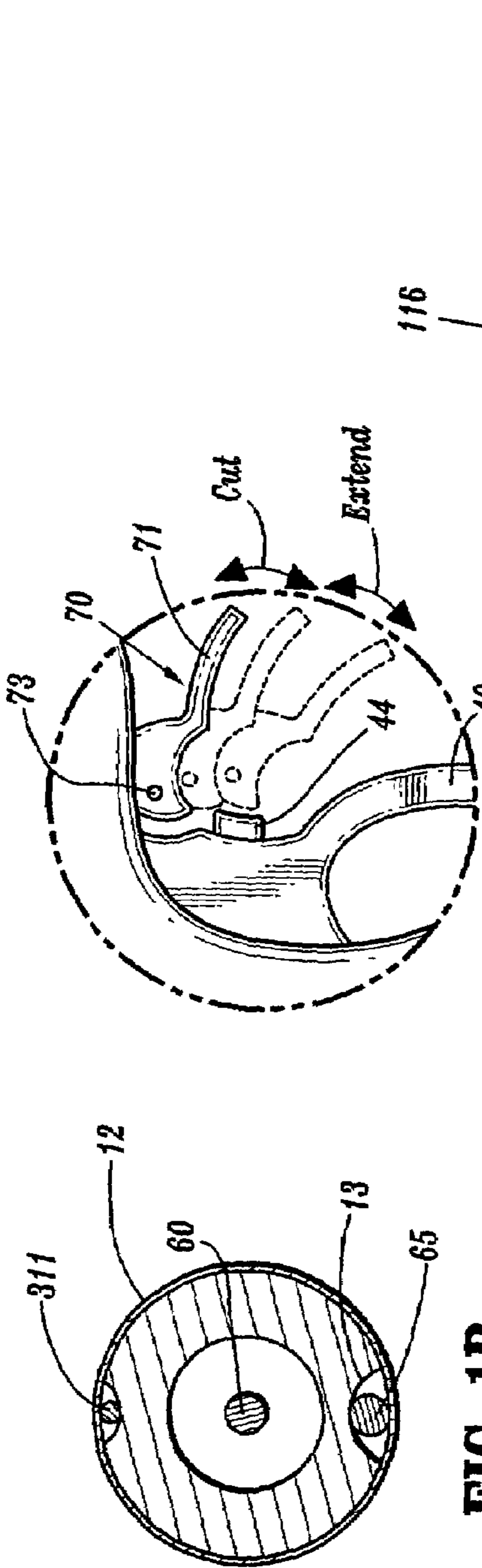


FIG. 1C

FIG. 1B

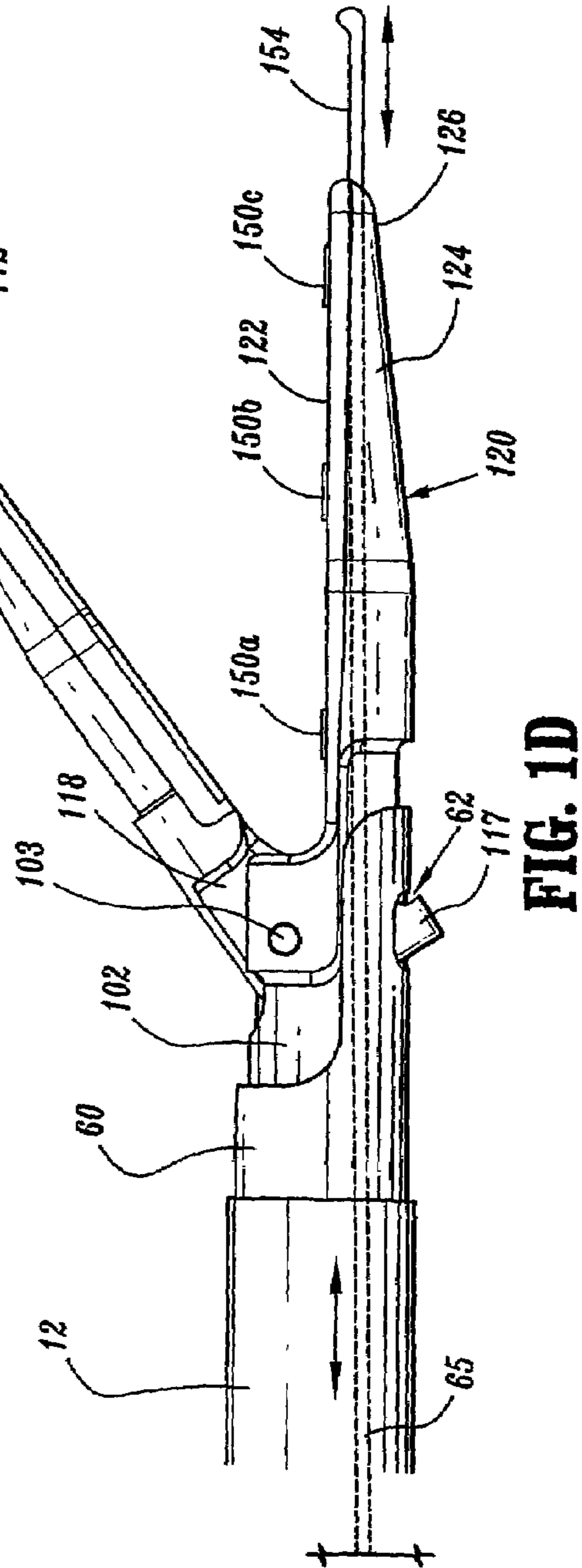


FIG. 1D

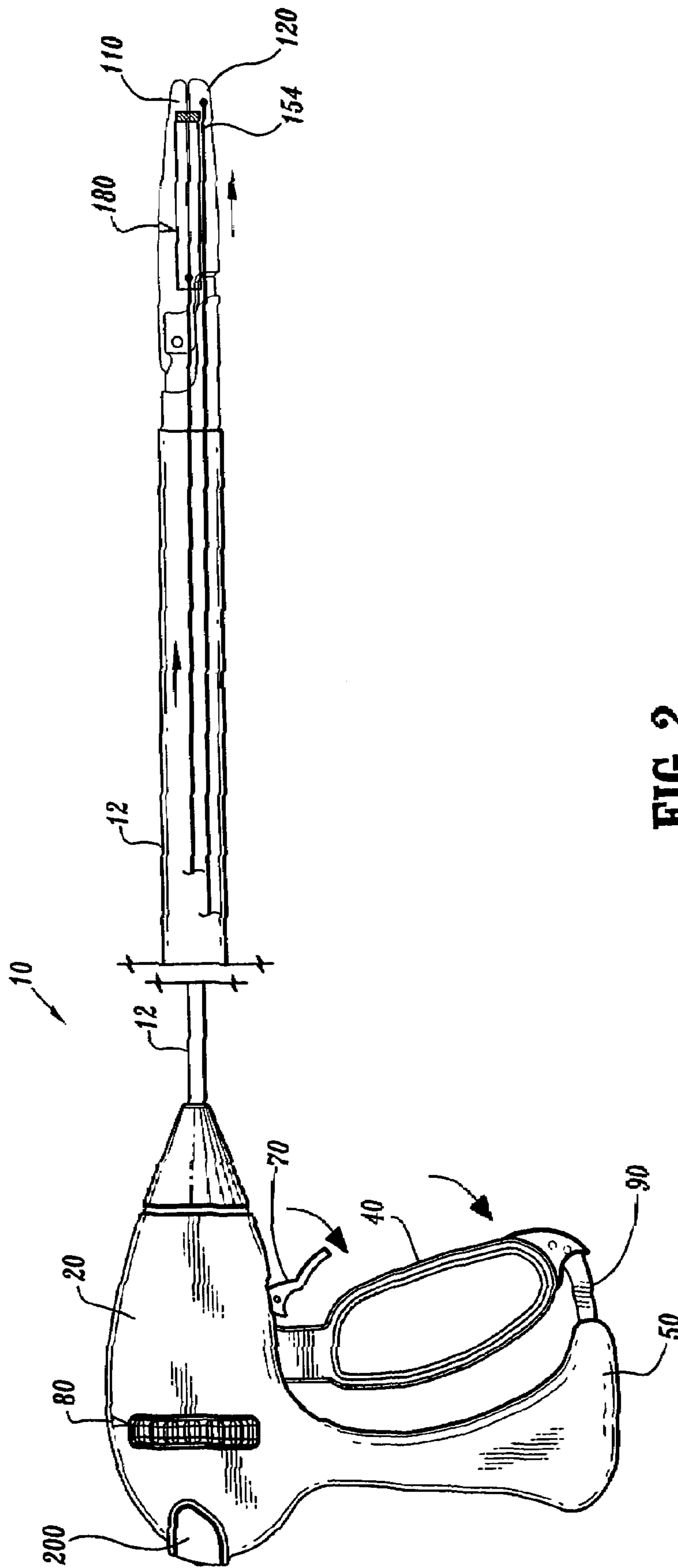


FIG. 2

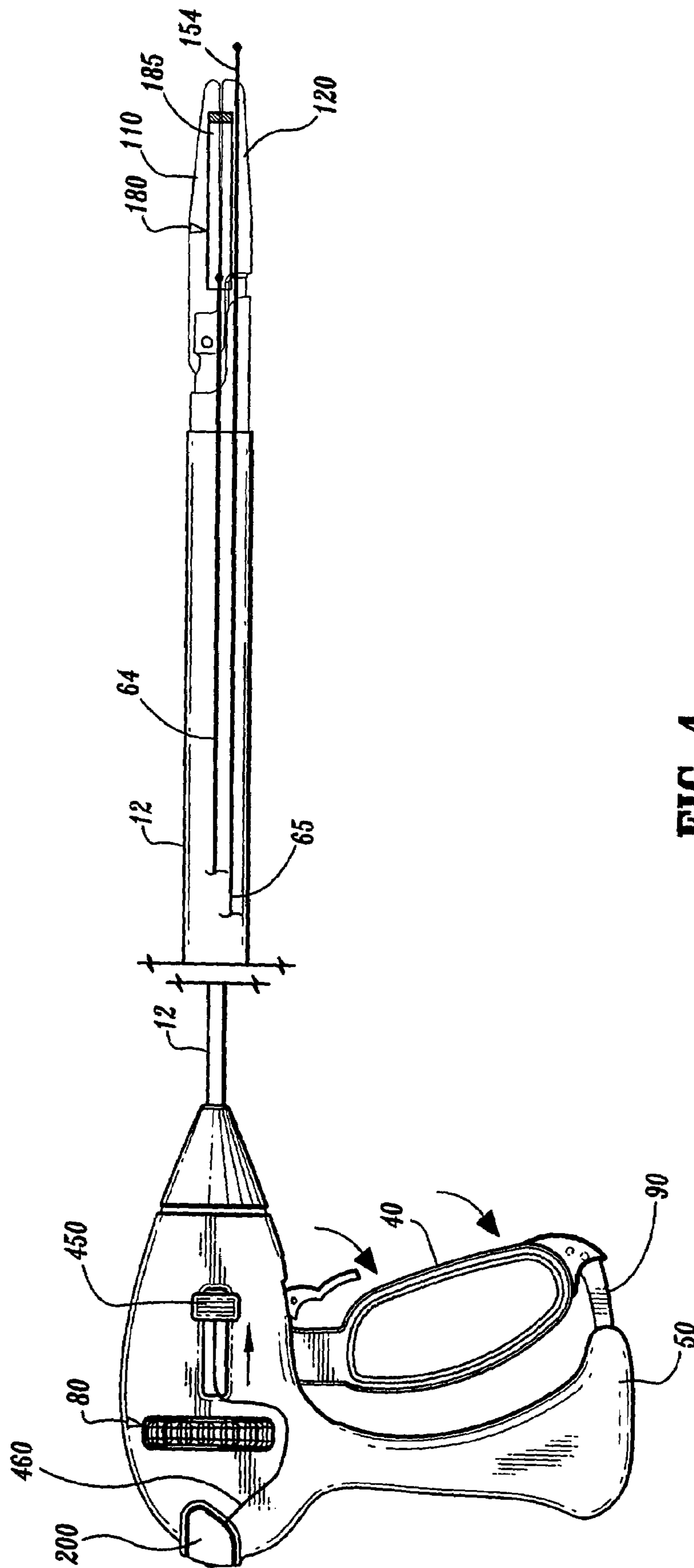
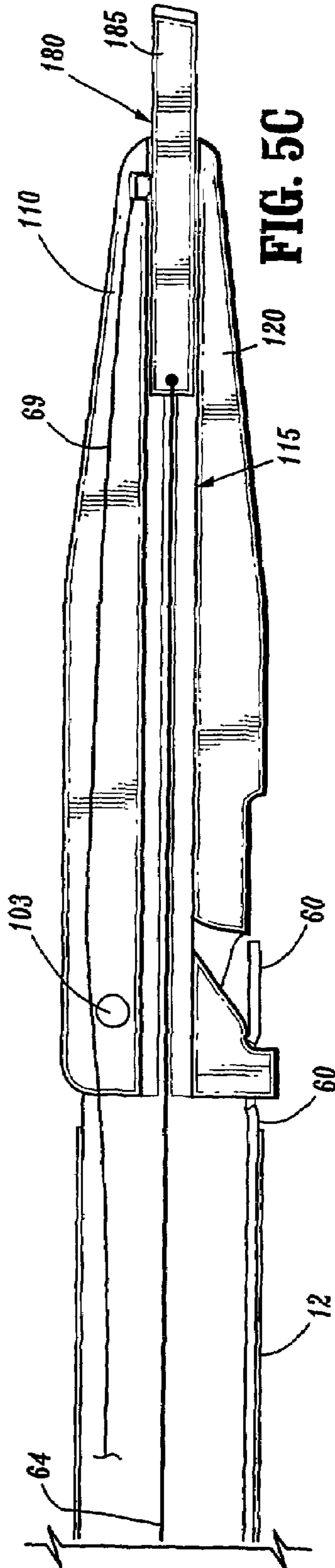
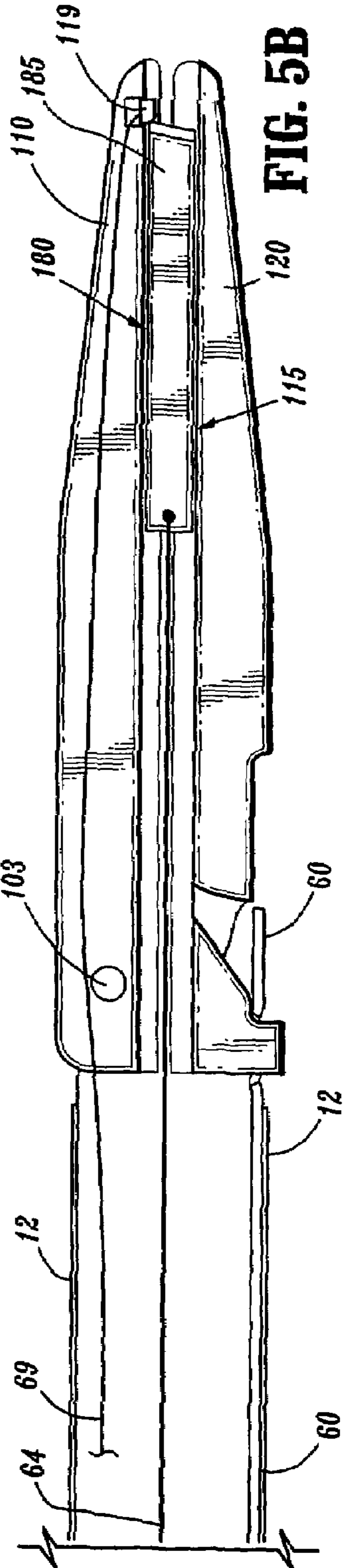
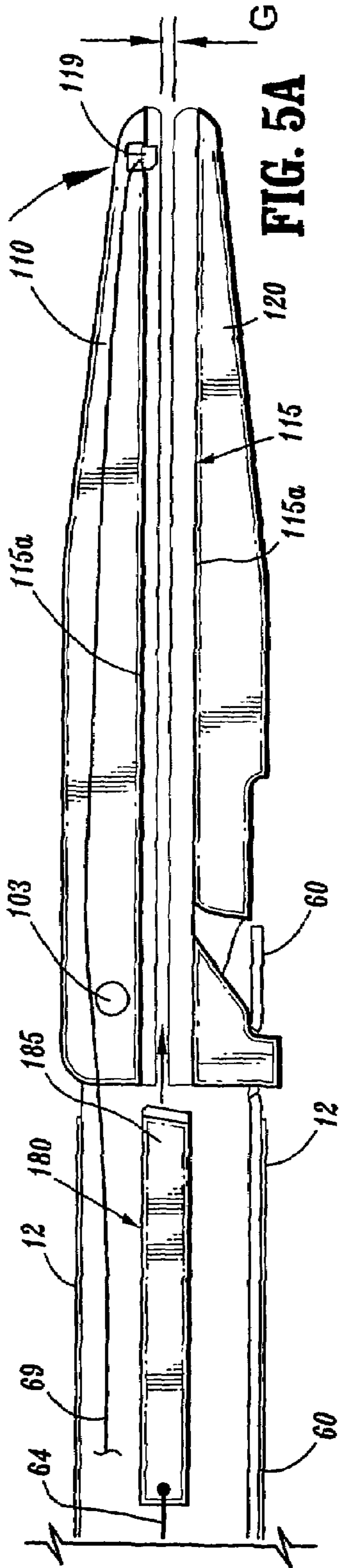


FIG. 4



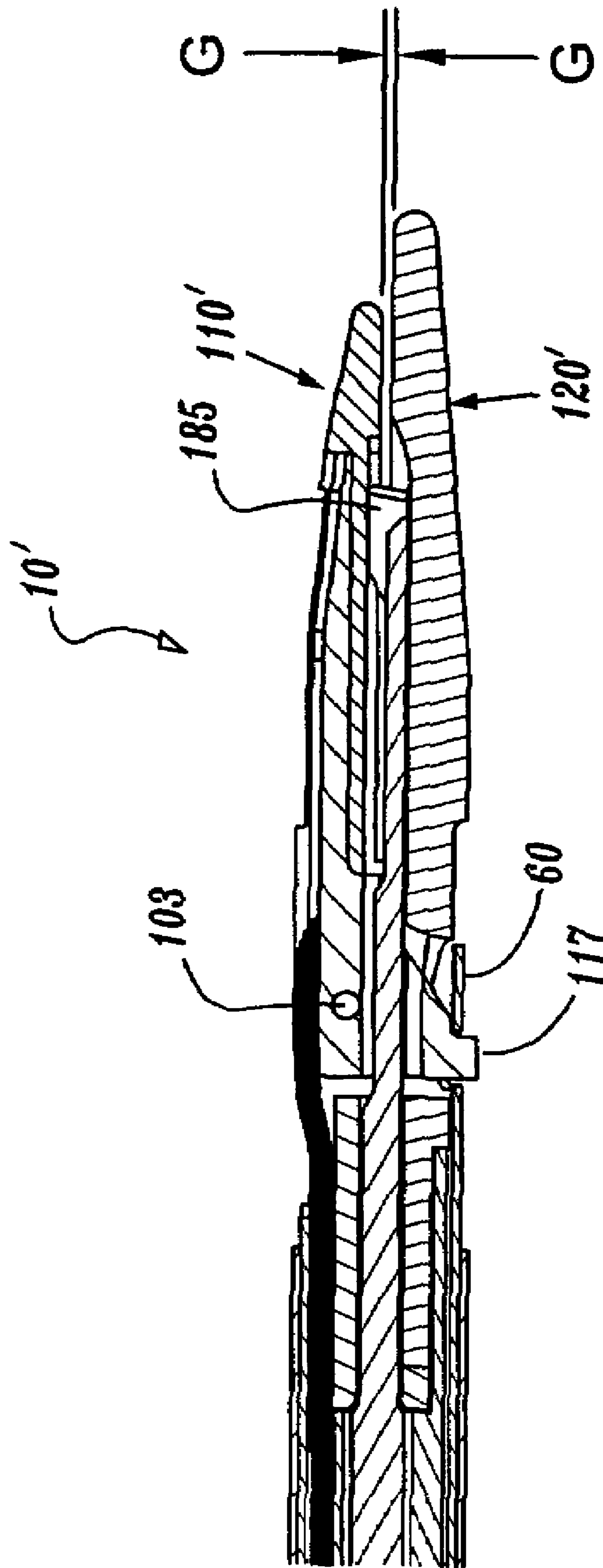


FIG. 6A

Mode	A	B	C
Off	Off	Off	Off
Bi Polar	Off	-	+
Mono Polar	-	+	+

FIG. 6C

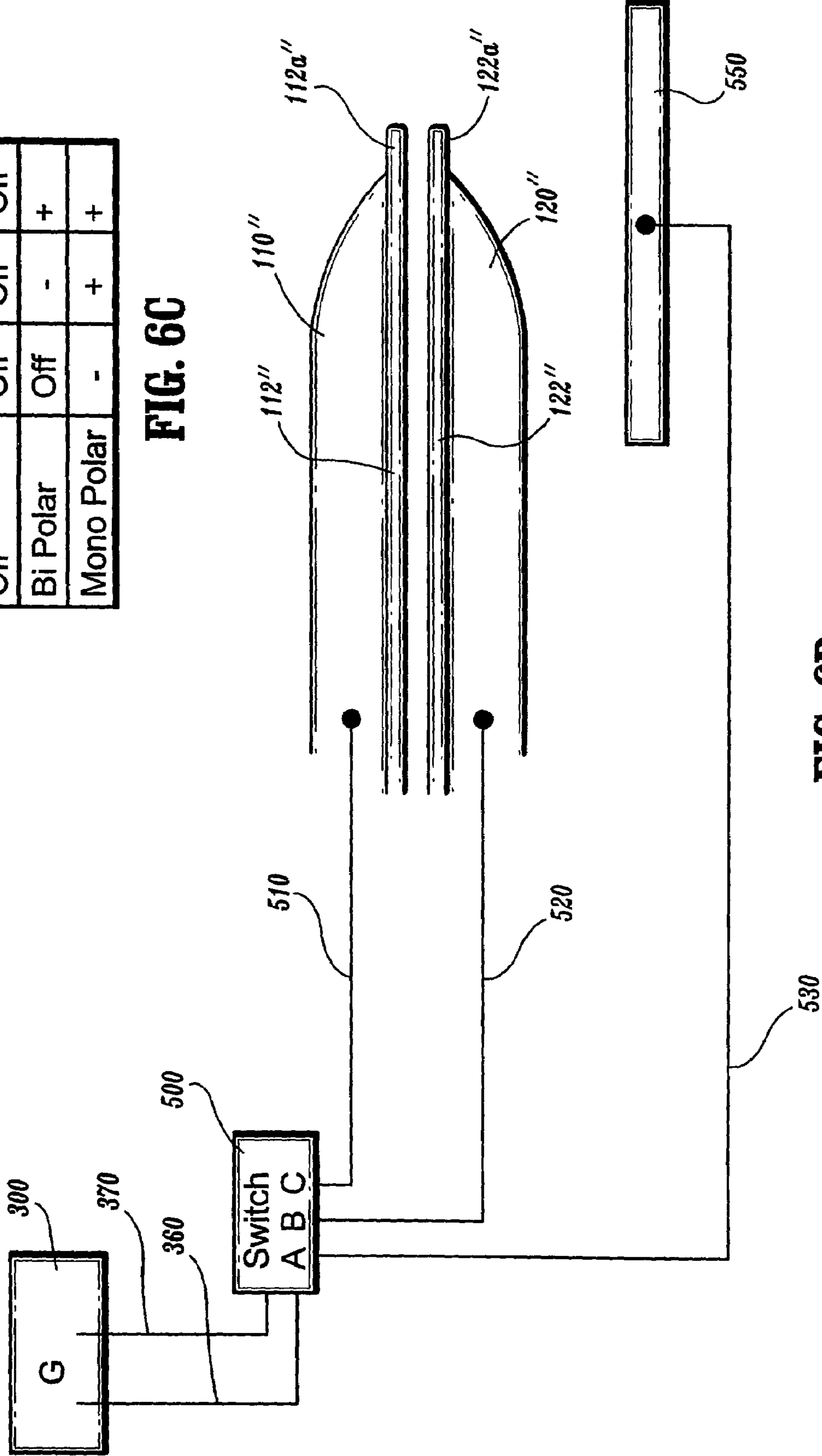


FIG. 6B

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BIPOLAR FORCEPS HAVING MONOPOLAR EXTENSION**CROSS REFERENCE TO RELATED APPLICATION**

This application claims the benefit of priority to U.S. Provisional Application Ser. No. 60/520,579 file on Nov. 17, 2003 by Lawes et al. Entitled "BIPOLAR FORCEPS HAVING MONOPOLAR EXTENSION" the entire contents of which being incorporated by reference herein.

BACKGROUND

The present disclosure relates to an electro-surgical forceps and more particularly, the present disclosure relates to an endoscopic bipolar electro-surgical forceps for coagulating, sealing and/or cutting tissue having a selectively energizable and/or extendable monopolar extension for enhanced electro-surgical effect.

TECHNICAL FIELD

Electro-surgical forceps utilize both mechanical clamping action and electrical energy to effect hemostasis by heating the tissue and blood vessels to coagulate, cauterize and/or seal tissue. As an alternative to open forceps for use with open surgical procedures, many modern surgeons use endoscopes and endoscopic instruments for remotely accessing organs through smaller, puncture-like incisions. As a direct result thereof, patients tend to benefit from less scarring and reduced healing time.

Endoscopic instruments are inserted into the patient through a cannula, or port, which has been made with a trocar. Typical sizes for cannulas range from three millimeters to twelve millimeters. Smaller cannulas are usually preferred, which, as can be appreciated, ultimately presents a design challenge to instrument manufacturers who must find ways to make endoscopic instruments that fit through the smaller cannulas.

Many endoscopic surgical procedures require cutting or ligating blood vessels or vascular tissue. Due to the inherent spatial considerations of the surgical cavity, surgeons often have difficulty suturing vessels or performing other traditional methods of controlling bleeding, e.g., clamping and/or tying-off transected blood vessels. By utilizing an electro-surgical scissors, the surgeon may cut tissue during a given surgical procedure utilizing a combination of mechanical cutting action and electro-surgical cutting. By utilizing an endoscopic electro-surgical forceps, a surgeon can cauterize, coagulate/desiccate and/or simply reduce or slow bleeding simply by controlling the intensity, frequency and duration of the electro-surgical energy applied through the jaw members to the tissue.

For treating larger vessels, a surgeon may opt to seal the tissue or vessel. Tissue sealing is fundamentally different than simply coagulating or cauterizing vessels. For the purposes herein, "coagulation" is defined as a process of desiccating tissue wherein the tissue cells are ruptured and dried. "Vessel sealing" or "tissue sealing" is defined as the process of liquefying the collagen in the tissue so that it reforms into a fused mass with limited demarcation between adjacent tissue structures. In order to effectively seal larger vessels (or tissue) two predominant mechanical parameters must be accurately controlled—the pressure applied to the vessel (tissue) preferably about 3 kg/cm² to about 16 kg/cm² and the gap distance between the electrodes preferably about

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0.001 inches to about 0.006 inches. Several examples of endoscopic vessel sealing instruments are disclosed in commonly-owned U.S. patent application Ser. Nos. 10/116,944, 10/179,863, 10/369,894 and 10/180,926 and PCT/US01/11340 the entire contents of all of which are hereby incorporated by reference herein.

Generally, the electrical configuration of electro-surgical forceps can be categorized in two classifications: 1) monopolar electro-surgical forceps; and 2) bipolar electro-surgical forceps. Monopolar forceps utilize one active electrode associated with the clamping end effector and a remote patient return electrode or pad which is attached externally to the patient. When the electro-surgical energy is applied, the energy travels from the active electrode, to the surgical site, through the patient and to the return electrode.

Bipolar electro-surgical forceps utilize two generally opposing electrodes which are disposed on the inner opposing surfaces of end effectors and which are both electrically coupled to an electro-surgical generator. Each electrode is charged to a different electric potential. Since tissue is a conductor of electrical energy, when the effectors are utilized to grasp, seal or cut tissue therebetween, the electrical energy can be selectively transferred through the tissue.

One of the inherent disadvantages to utilizing a bipolar endoscopic forceps for cauterizing, coagulating cutting or sealing vessels and other tissues is the inability of the bipolar forceps to match the benefits or advantages of monopolar instruments (i.e., monopolar instruments have the ability to move through avascular tissue and dissect through narrow tissue planes) necessitating the need for the surgeon to replace the bipolar forceps during surgery to reap the benefits of using the monopolar instrument for certain applications. Likewise, during some monopolar endoscopic applications it may be advantageous to replace the monopolar instrument with a bipolar forceps, e.g., for sealing large tissue structures. For example, during a cholecystectomy the gallbladder is dissected from the liver which would typically entail using an endoscopic monopolar instrument, e.g., electro-surgical blade, electro-surgical pencil, loop electrode, etc. However, during the cholecystectomy procedure there may also be a need to seal the cystic duct or cystic artery which may require a bipolar vessel sealing instrument necessitating the need to replace the monopolar instrument. The surgeon may need to repeatedly remove the monopolar instrument from the operating cavity to utilize the bipolar instrument and vice versa.

Thus there exists a need to develop an instrument which can combine the benefits of both monopolar and bipolar operation thereby reducing the need for the surgeon to substitute instruments during surgical certain procedures.

SUMMARY

The present disclosure relates to an endoscopic forceps for treating tissue and includes a housing having a shaft affixed thereto and first and second jaw members attached to a distal end of the shaft. The forceps also includes an actuator for moving jaw members relative to one another from a first position wherein the jaw members are disposed in spaced relation relative to one another to a second position wherein the jaw members cooperate to grasp tissue therebetween. A source of electro-surgical energy is connected to each jaw member such that the jaw members are selectively capable of operating in a bipolar mode which enables the jaw members to conduct bipolar energy through tissue held therebetween to treat tissue. The forceps also includes a monopolar element housed within at least the first jaw

member which is selectively movable from a first position within the first jaw member to a second position distal to the first jaw member. The monopolar element is connected to the source of electrosurgical energy and is selectively activateable independent of the jaw members.

In one embodiment according to the present disclosure, the forceps includes a knife which is selectively moveable within a knife channel defined within at least one of the first and second jaw members to cut tissue disposed between the first and second jaw members. Advantageously, a knife actuator allows a user to selectively move the knife to cut tissue disposed between the jaw members. The source of electrosurgical energy carries electrical potentials to each respective jaw member such that the jaw members are capable of conducting bipolar energy through tissue held therebetween to effect a tissue seal.

Advantageously, the knife is designed to initially cut tissue disposed between the first and second jaw members and subsequently extend distally from the jaw members to treat tissue in a monopolar fashion. Preferably, the forceps includes a safety (e.g. a safety circuit or mechanical safety element) which only allows electrical activation of the knife (or monopolar element) when the knife (or monopolar element) is extended from the distal ends of the jaw members. The safety may also deactivate the jaw members through circuitry or utilizing a mechanical safety element.

In one embodiment, the first jaw member and the second jaw member each include an elongated slot which runs in opposition substantially along the respective lengths thereof such that the two opposing elongated slots form the knife channel for reciprocating the knife to divide tissue disposed between the two jaw members.

In another embodiment, the forceps is a vessel sealing forceps and at least one of the jaw members includes at least one non-conductive stop member disposed thereon which controls the distance between the first and second jaw members when tissue is held therebetween. Advantageously, the stop member(s) maintains a gap distance of about 0.001 inches to about 0.006 inches between the jaw members when tissue is compressed between the jaw members.

In yet another embodiment according to the present disclosure, the forceps includes an actuator which operates to both move the knife to cut tissue disposed between jaw members and to extend the knife or a separate monopolar element from the first position within the first jaw member to the second position distal to the first jaw member. In still yet another embodiment according to the present disclosure, the forceps includes an actuator which operates to both move the jaw members relative to one another from the first to second positions to grasp tissue therebetween and to extend the monopolar element from the first position within the first jaw member to the second position distal to the first jaw member.

In another embodiment according to the present disclosure, a first actuator may be designed to operate the jaw members for grasping tissue and a second actuator may be included which operates to extend the monopolar element from the first position within the first jaw member to the second position distal to the first jaw member.

The present disclosure also relates to an endoscopic forceps which includes a housing having a shaft affixed thereto and first and second jaw members attached to a distal end of the shaft. The first jaw member is configured to extend distally relative to the second jaw member. An actuator is included for moving jaw members relative to one another from a first position wherein the jaw members are disposed in spaced relation relative to one another to a second position

wherein the jaw members cooperate to grasp tissue therebetween. The jaw members are connected to a source of electrosurgical energy such that the jaw members are selectively capable of operating in a bipolar mode which enables the jaw members to conduct bipolar energy through tissue held therebetween.

The forceps also includes a control switch which, upon selective activation, deactivates the second jaw member and activates the first jaw member with a first electrical potential. At relatively the same time, the control switch also activates a return electrode or return pad with a different electrical potential which is placed adjacent to the patient to enable the first jaw member to selectively treat tissue in a monopolar fashion. Preferably, a safety is included which limits electrical activation of the control switch to when the jaw members are disposed in the second position.

The present disclosure also relates to an endoscopic forceps which includes a housing having a shaft affixed thereto. The shaft includes first and second jaw members attached to a distal end thereof. Preferably, the first and second jaw members each include a tapered or elongated distal end.

The forceps also includes an actuator for moving jaw members relative to one another from a first position wherein the jaw members are disposed in spaced relation relative to one another to a second position wherein the jaw members cooperate to grasp tissue therebetween. A source of electrosurgical energy is connected to each jaw member such that the jaw members are selectively capable of operating in a bipolar mode which enables the jaw members to conduct bipolar energy through tissue held therebetween.

A control switch is also included which, upon selective activation thereof, activates the first jaw member and the second jaw member with a first electrical potential and activates a return electrode with a different electrical potential. The return electrode is preferably placed adjacent to the patient which enables the first and second jaw members to selectively treat tissue in a monopolar fashion. Preferably, the forceps includes a safety which only allows electrical activation of the control switch when the jaw members are disposed in the second position.

In another embodiment of the present disclosure, the actuator is selectively lockable to maintain a closure pressure in the range of about 3 kg/cm² to about 16 kg/cm² and, preferably, about 7 kg/cm² to about 13 kg/cm² between the jaw members which is advantageous in producing effective and reliable tissue seals. In yet another embodiment, the forceps may also include a rotating assembly for rotating the jaw members about a longitudinal axis defined through the shaft. Advantageously, the forceps includes a unilateral jaw assembly, i.e., the first jaw member is movable relative to the second jaw member and the second jaw member is substantially fixed.

Alternatively, the forceps may include a bilateral jaw assembly, i.e., both jaw members move relative to one another.

Preferably, a spring is included with the actuator or drive assembly to facilitate actuation of the movable handle and to assure the closure force is maintained within a working range of about 3 kg/cm² to about 16 kg/cm².

The present disclosure also relates to a method for treating tissue with electrosurgical energy from an electrosurgical generator which includes the steps of: providing an endoscopic forceps including a housing having a shaft affixed thereto. The shaft includes first and second jaw members attached to a distal end thereof. An actuator is included for moving jaw members relative to one another from a first

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position wherein the jaw members are disposed in spaced relation relative to one another to a second position wherein the jaw members cooperate to grasp tissue therebetween. A monopolar element is also included which is housed within at least the first jaw member and selectively movable from a first position within the first jaw member to a second position distal to the first jaw member. A return electrode is provided and placed in contact with patient tissue.

The method also includes the steps of: connecting to each jaw member, the monopolar element and the return electrode to the electrosurgical generator; grasping tissue between the jaw members; selectively activating the jaw members to treat tissue disposed between the jaw members in a bipolar fashion; and selectively activating the monopolar element and the return electrode independent of the jaw members to treat tissue in a monopolar fashion.

Preferably, after the step of selectively activating the jaw members to treat tissue, the method includes the step of: extending the monopolar element from the distal end of the jaw members. Advantageously, the step of selectively activating the monopolar element includes deactivating the jaw members.

After the step of selectively activating the jaw members to treat tissue, the method may include the step of: releasing the tissue from the jaw members.

BRIEF DESCRIPTION OF THE DRAWINGS

Various embodiments of the subject instrument are described herein with reference to the drawings wherein:

FIG. 1A is a side view of an endoscopic forceps showing a housing, a shaft, an end effector assembly and a trigger assembly in a first position according to the present disclosure;

FIG. 1B is an enlarged, cross section taken along line 1B-1B of FIG. 1A;

FIG. 1C is an enlarged, side view of the trigger assembly of FIG. 1A;

FIG. 1D is an enlarged, side view of the embodiment of an end effector assembly of FIG. 1A showing relative extension of a monopolar element from a distal end of the end effector assembly;

FIG. 2 is a side view of the trigger assembly in a second position for advancing a knife within the end effector assembly;

FIG. 3 is a side view of the trigger assembly in a third position for extending a monopolar element from a distal end of the end effector assembly;

FIG. 4 is a side view of an alternate embodiment of the present invention showing a second actuator advancing the monopolar element relative to the distal end of the end effector assembly;

FIG. 5A is an enlarged, side schematic view of one embodiment of an end effector assembly showing relative movement of a first jaw member relative to a second jaw member prior to advancement of the knife through the end effector assembly;

FIG. 5B is an enlarged, side schematic view of the end effector assembly showing relative movement of the knife through the end effector assembly to divide tissue;

FIG. 5C is an enlarged, side schematic view of the end effector assembly showing relative movement of the knife extending from the distal end of the end effector assembly;

FIG. 6A is an enlarged, side schematic view of another embodiment of an end effector assembly showing a first jaw member extending beyond a second jaw member;

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FIG. 6B is schematic view of another embodiment of an end effector assembly showing a series of electrical connections to a control switch and a generator to enable both bipolar activation and monopolar activation; and

FIG. 6C is a table showing the various modes of operation of the forceps utilizing the end effector configuration of FIG. 6B.

DETAILED DESCRIPTION

Turning now to FIGS. 1A-1D, one embodiment of an endoscopic forceps **10** is shown for use with various surgical procedures. For the purposes herein, a vessel sealing forceps is shown and described, however, it is envisioned that other types of forceps or scissors may be utilized which both treat tissue for cauterization, coagulation or other purposes and which may be configured for monopolar applications as described herein. Moreover, although the figure drawings depict a forceps **10** for use in connection with endoscopic surgical procedures, the present disclosure may be used for more traditional open surgical procedures. For the purposes herein, the forceps **10** is described in terms of an endoscopic instrument, however, it is contemplated that an open version of the forceps **10** may also include the same or similar operating components and features as described below.

Forceps **10** generally includes a housing **20**, a handle assembly **30**, a rotating assembly **80**, a trigger assembly **70** and an end effector assembly **100** which mutually cooperate to grasp, treat and divide tissue. For the purposes herein, the handle assembly **30**, rotating assembly, trigger assembly **70** and end effector assembly **100** are only generally described. A more detailed explanation of all of these cooperating elements are described in commonly owned, co-pending U.S. patent application Ser. No. 10/460,926 the entire contents of which is hereby incorporated by reference herein.

Forceps **10** includes a shaft **12** which has a distal end **16** dimensioned to mechanically engage the end effector assembly **100** and a proximal end **14** which mechanically engages the housing **20**. In the drawings and in the descriptions which follow, the term "proximal", as is traditional, will refer to the end of the forceps **10** which is closer to the user, while the term "distal" will refer to the end which is further from the user. Details of how the shaft **12** connects to the end effector assembly **100** and how the proximal end connects to the housing **20** are explained in the above-mentioned commonly owned, co-pending U.S. patent application Ser. No. 10/460,926.

As best seen in FIG. 1A, forceps **10** also includes an electrosurgical cable **310** which connects the forceps **10** to a source of electrosurgical energy, e.g., a generator **300**. Cable **310** is internally divided into cable leads **310a**, **310b** and **310c** which each transmit electrosurgical energy through their respective feed paths through the forceps **10** to the end effector assembly **100** as explained in more detail with respect to U.S. patent application Ser. No. 10/460,926. Preferably, generators such as those sold by Valleylab—a division of Tyco Healthcare LP, located in Boulder Colo. are used as a source of electrosurgical energy, e.g., FORCE EZ™ Electrosurgical Generator, FORCE FX™ Electrosurgical Generator, FORCE 1C™ Electrosurgical Generator, FORCE 2™ Electrosurgical Generator, SurgiStat™ II Electrosurgical Generator. One such system is described in commonly-owned U.S. Pat. No. 6,033,399 the entire contents of which are hereby incorporated by reference herein. Other systems have been described in commonly-owned U.S. Pat. No. 6,187,003 the entire contents of which is also incorporated by reference herein.

Preferably, the generator **300** includes various safety and performance features including isolated output, independent activation of accessories. Preferably, the electrosurgical generator **300** includes Valleylab's Instant Response™ technology which provides an advanced feedback system to sense changes in tissue **200** times per second and adjust voltage and current to maintain appropriate power.

Handle assembly **30** includes a fixed handle **50** and a movable handle **40**. Fixed handle **50** is integrally associated with housing **20** and handle **40** is movable relative to fixed handle **50**. Rotating assembly **80** is preferably integrally associated with the housing **20** and is rotatable approximately 180 degrees in either direction about a longitudinal axis "A". Details of the handle assembly **30** and the rotating assembly **80** are described in more detail with respect to U.S. patent application Ser. No. 10/460,926.

As mentioned above, end effector assembly **100** is attached at the distal end **16** of shaft **12** and includes a pair of opposing jaw members **110** and **120**. Movable handle **40** of handle assembly **30** is ultimately connected to an internally disposed drive assembly (not shown) which, together, mechanically cooperate to impart movement of the jaw members **110** and **120** from an open position wherein the jaw members **110** and **120** are disposed in spaced relation relative to one another, to a clamping or closed position wherein the jaw members **110** and **120** cooperate to grasp tissue therebetween.

Turning now to the more detailed features of one embodiment of the present disclosure as described with respect to FIGS. 1A-3, movable handle **40** includes an aperture **42** defined therethrough which enables a user to grasp and move the handle **40** relative to the fixed handle **50**. More particularly, handle **40** is selectively moveable about a pivot (not shown) from a first position relative to fixed handle **50** to a second position in closer proximity to the fixed handle **50** which imparts movement of the jaw members **110** and **120** relative to one another.

The lower end of the movable handle **40** includes a flange **90** which, upon movement of the handle **40** proximally, is reciprocated within fixed handle **50**. Flange **90** rides within a predefined channel (not shown) disposed within fixed handle **50** to lock the movable handle **40** relative to the fixed handle **50**.

As best shown in FIG. 1C, a locking flange **44** is disposed on the outer periphery of the handle **40** above the upper portion of the handle **40**. Locking flange **44** prevents the trigger assembly **70** from firing when the handle **40** is oriented in a non-actuated position, i.e., the jaw members **110** and **120** are open. As can be appreciated, this prevents accidental or premature severing of tissue prior to completion of a tissue seal.

As explained in detail in co-pending U.S. patent application Ser. No. 10/460,926, movable handle **40** is designed to provide a distinct mechanical advantage over conventional handle assemblies due to the unique position of the pivot point relative to the longitudinal axis "A" of the shaft **12**. In other words, by positioning the pivot point above the driving element, the user gains lever-like mechanical advantage to actuate the jaw members **110** and **120** enabling the user to close the jaw members **110** and **120** with lesser force while still generating the required forces necessary to effect a proper and effective tissue seal. It is also envisioned that the unilateral design of the end effector assembly **100** will also increase mechanical advantage.

As best seen in FIGS. 1A and 1D, the end effector assembly **100** includes opposing jaw members **110** and **120** which cooperate to effectively grasp tissue for sealing pur-

poses. The end effector assembly **100** is designed as a unilateral assembly, i.e., jaw member **120** is fixed relative to the shaft **12** and jaw member **110** pivots about a pivot pin **103** to grasp tissue.

More particularly, the unilateral end effector assembly **100** includes one stationary or fixed jaw member **120** mounted in fixed relation to the shaft **12** and pivoting jaw member **110** mounted about a pivot pin **103** attached to the stationary jaw member **120**. A reciprocating sleeve **60** is slidably disposed within the shaft **12** and is remotely operable by the drive assembly (not shown) which cooperates with handle **40** as explained above to open and close the jaw members **110** and **120**. The pivoting jaw member **110** includes a detent or protrusion **117** which extends from jaw member **110** through an aperture **62** disposed within the reciprocating sleeve **60** (FIG. 1D). The pivoting jaw member **110** is actuated by sliding the sleeve **60** axially within the shaft **12** such that aperture **62** abuts against the detent **117** on the pivoting jaw member **110**. Pulling the sleeve **60** proximally closes the jaw members **110** and **120** about tissue grasped therebetween and pushing the sleeve **60** distally opens the jaw members **110** and **120** for approximating and grasping purposes.

Once actuated, handle **40** moves in a generally arcuate fashion towards fixed handle **50** about the pivot point which forces the driving flange (not shown) proximally against the drive assembly (not shown) which, in turn, pulls reciprocating sleeve **60** in a generally proximal direction to close jaw member **110** relative to jaw member **120**. Moreover, proximal rotation of the handle **40** causes the locking flange **44** to release, i.e., "unlock" the trigger assembly **70** for selective actuation. These features are shown and explained in detail with reference to commonly-owned, co-pending U.S. application Ser. No. 10/460,926.

As best illustrated in FIGS. 5A-5C, a knife channel **115a** and **115b** runs through the center of the jaw members **110** and **120**, respectively, such that a blade **185** can cut tissue grasped between the jaw members **110** and **120** when the jaw members **110** and **120** are in a closed position. More particularly, the blade **185** can only be advanced through the tissue when the jaw members **110** and **120** are closed thus preventing accidental or premature activation of the blade **185** through tissue. Put simply, the knife channel **115** (made up of half channels **115a** and **115b**) is blocked when the jaws members **110** and **120** are opened and aligned for distal activation when the jaw members **110** and **120** are closed.

As best shown in FIG. 1D, jaw member **110** includes a jaw housing **116** which has an insulative substrate or insulator **114** and an electrically conductive surface **112**. Insulator **114** is preferably dimensioned to securely engage the electrically conductive sealing surface **112**. This may be accomplished by stamping, by overmolding, by overmolding a stamped electrically conductive sealing plate, by overmolding a metal injection molded seal plate and/or other ways known in the art. It is envisioned a trigger lead **311** from switch **200** electrically connects to the seal plate **112**.

All of these manufacturing techniques produce jaw member **110** having an electrically conductive surface **112** which is substantially surrounded by an insulating substrate **114**. The insulator **114**, electrically conductive sealing surface **112** and the outer, non-conductive jaw housing **116** are preferably dimensioned to limit and/or reduce many of the known undesirable effects related to tissue sealing, e.g., flashover, thermal spread and stray current dissipation.

As best seen in FIG. 1D, jaw member **110** also includes a pivot flange **118** which includes protrusion **117**. Protrusion **117** extends from pivot flange **118** and includes an arcuately-

shaped inner surface dimensioned to matingly engage the aperture 62 of sleeve 60 upon retraction thereof. Pivot flange 118 is also dimensioned to engage pivot pin 103 to allow jaw member 110 to rotate relative to jaw member 120 upon retraction of the reciprocating sleeve 60. Pivot pin 103 also mounts to the stationary jaw member 120 within a proximal portion of jaw member 120.

Preferably, the electrically conductive surface 112 and the insulator 114, when assembled, form the longitudinally-oriented knife slot 115a defined therethrough for reciprocation of the knife blade 185. As mentioned above, knife channel 115a cooperates with corresponding knife channel 115b defined in stationary jaw member 120 to facilitate longitudinal translation of the knife blade 185 along a preferred cutting plane to effectively and accurately separate tissue along the formed tissue seal.

Jaw member 120 includes similar elements to jaw member 110 such as jaw housing 126 having an insulator 124 and an electrically conductive sealing surface 122 which is dimensioned to securely engage the insulator 124. Likewise, the electrically conductive surface 122 and the insulator 124, when assembled, include longitudinally-oriented channel 115b defined therethrough for reciprocation of the knife blade 185. As mentioned above, when the jaw members 110 and 120 are closed about tissue 420, knife channels 115a and 115b form a complete knife channel 115 to allow longitudinal translation of the knife 185 in a distal fashion to sever tissue along the tissue seal.

As mentioned above, jaw member 120 may include a series of stop members 150a-150c preferably disposed on the inner facing surfaces of the electrically conductive sealing surface 122 to facilitate gripping and manipulation of tissue and to define a gap "G" (FIG. 5A) between opposing jaw members 110 and 120 during sealing and cutting of tissue. It is envisioned that the series of stop members 150a-150c may be employed on one or both jaw members 110 and 120 depending upon a particular purpose or to achieve a desired result. A detailed discussion of these and other envisioned stop members 150a-150c as well as various manufacturing and assembling processes for attaching and/or affixing the stop members 150a-150c to the electrically conductive sealing surfaces 112, 122 are described in commonly-assigned, co-pending U.S. Application Serial No. PCT/US01/11413 which is hereby incorporated by reference in its entirety herein.

Jaw member 120 is designed to be fixed to the end of a rotating tube (not shown) which is part of the rotating assembly 80 such that rotation of the tube will impart rotation to the end effector assembly 100. Jaw member 120 is connected to a second electrical potential through the rotating tube (not shown) which is connected at its proximal end to a lead 310c from cable 310. Details relating to the mechanical and electromechanical engagement of the jaw member 120 to the rotating assembly 80 are described in above-mentioned, commonly-owned, co-pending U.S. patent application Ser. No. 10/460,926.

As mentioned above, the jaw members 110 and 120 may be opened, closed and rotated to manipulate tissue until sealing is desired. This enables the user to position and re-position the forceps 10 prior to activation and sealing. As illustrated in FIG. 1A, the end effector assembly 100 is rotatable about longitudinal axis "A" through rotation of the rotating assembly 80. It is envisioned that the unique feed path of the trigger lead 311 from the switch 200 through the rotating assembly 80, along shaft 12 and, ultimately, to the jaw member 110 enables the user to rotate the end effector assembly 100 about 180 degrees in both the clockwise and

counterclockwise direction without tangling or causing undue strain on the cable lead. The other cable lead 310c from cable 310 is fused or clipped to the proximal end of the rotating tube (not shown) and is generally unaffected by rotation of the jaw members 110 and 120. As can be appreciated, this facilitates the grasping and manipulation of tissue.

Again as best shown in FIGS. 1A and 1C, trigger assembly 70 mounts atop movable handle 40 and cooperates with the knife assembly 180 (FIGS. 2, 3, 4, and 5A-5C) to selectively translate knife 185 through a tissue seal. More particularly, the trigger assembly 70 includes a finger actuator 71 and a pivot pin 73 which mounts the trigger assembly 70 to the housing 20. Finger actuator 71 is dimensioned to abut the locking flange 44 on handle 40 when the handle 40 is disposed in a non-actuated position, i.e., the jaw members 110 and 120 are opened.

The trigger assembly 70 is designed to cooperate with a drive bar 64 which connects to the knife assembly 180. Proximal activation of the finger actuator 71 rotates the trigger assembly 70 about pivot pin 73 which, in turn, forces the drive bar 64 distally, which ultimately extends the knife 185 through tissue. A spring (not shown) may be employed to bias the knife assembly 180 in a retracted position such that after severing tissue the knife 185 and the knife assembly 180 are automatically returned to a pre-firing position. In addition, when the handle 40 is actuated and flange 90 is fully reciprocated within fixed handle 50, the locking flange 44 moves proximally allowing activation of the trigger assembly 70.

As best shown in FIG. 1A, the cable 310 is fed through the bottom of the housing 20 through fixed handle 50. A first lead 310c extends directly from cable 310 into the rotating assembly 80 and connects (via a fused clip or spring clip or the like) to tube 60 to conduct the second electrical potential to fixed jaw member 120. Second and third leads 310a and 310b extend from cable 310 and connect to the hand switch or joy-stick-like toggle switch 200. Switch 200 permits the user to selectively activate the forceps 10 in a variety of different orientations, i.e., multi-oriented activation which simplifies activation. When the switch 200 is depressed, a trigger lead 311 carries the first electrical potential to jaw member 110. More particularly, the trigger lead 311 extends from switch 200 through the rotating assembly 80 and along the upper portion of the rotating tube (not shown) and eventually connects to the movable jaw member 110. As can be appreciated, locating the switch 200 on the forceps 10 has many advantages. For example, the switch 200 reduces the amount of electrical cable in the operating room and eliminates the possibility of activating the wrong instrument during a surgical procedure due to "line-of-sight" activation.

As explained in detail above, the second electrical potential (i.e., lead 310c) is conducted to jaw member 120 through the rotating tube. The two potentials are preferably isolated from one another by insulative sheathing (or the like) which surrounds the trigger lead. Preferably, the jaw members 110 and 120 are electrically isolated from one another such that bipolar electrosurgical energy can be effectively transferred through the tissue to form a tissue seal.

Once the desired position for the sealing site is determined and the jaw members 110 and 120 are properly positioned, handle 40 may be compressed fully such that the flange 90 is reciprocated and locked within fixed handle 50. Handle 40 is now secured in position relative to fixed handle 50 which, in turn, locks the jaw members 110 and 120 in a closed position about tissue. The forceps 10 is now ready for selective application of electrosurgical energy and subse-

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quent separation of tissue, i.e., when movable handle **10** reciprocates within fixed handle **50**, locking flange **44** moves into a position to permit activation of the trigger assembly **70** as explained above.

As can be appreciated, the combination of the mechanical advantage of the over-the-center pivot along with the assisting compressive forces associated with a compression spring (not shown) facilitate and assure consistent, uniform and accurate closure pressure about tissue within the desired working pressure range of about 3 kg/cm² to about 16 kg/cm² and, preferably about 7 kg/cm² to about 13 kg/cm². As mentioned above, at least one jaw member, e.g., **120**, may include a stop member e.g., **150a**, which limits the movement of the two opposing jaw members **110** and **120** relative to one another. Preferably, a series of stop members are to yield a consistent and accurate gap distance "G" during sealing (FIG. 5A) which ranges from about 0.001 inches to about 0.006 inches and, more preferably, between about 0.002 and about 0.003 inches. By controlling the intensity, frequency and duration of the electrosurgical energy applied to the tissue, the user can effectively seal the tissue along a predetermined tissue site.

As energy is being selectively transferred to the end effector assembly **100**, across the jaw members **110** and **120** and through the tissue, a tissue seal forms isolating two tissue halves. At this point and with other known vessel sealing instruments, the user must remove and replace the forceps **10** with a cutting instrument (not shown) to divide the tissue halves along the tissue seal which is both time consuming and tedious and may result in inaccurate tissue division across the tissue seal due to misalignment or misplacement of the cutting instrument along the ideal tissue cutting plane.

The present disclosure incorporates knife assembly **180** which, when activated via the trigger assembly **70**, progressively and selectively divides the tissue along an ideal tissue plane in precise manner to effectively and reliably divide the tissue. The knife assembly **180** allows the user to quickly separate the tissue immediately after sealing without substituting a cutting instrument through a cannula or trocar port. As can be appreciated, accurate sealing and dividing of tissue is accomplished with the same forceps **10**.

Once the tissue is divided into tissue halves, the jaw members **110** and **120** may be opened by re-grasping the handle **40** which release the flange **90** from fixed handle **50**. Details relating to the releasing of the flange from handle are described in commonly-owned, co-pending U.S. application Ser. No. 10/460,926.

Turning now to the operating characteristics of the present disclosure and as seen in the majority of the figures, forceps **10** is designed for both bipolar electrosurgical treatment of tissue (either by vessel sealing as described above or coagulation or cauterization with other similar instruments) and monopolar treatment of tissue. For example, FIGS. 1A-D and 2-4 show one embodiment of a forceps **10** which includes a monopolar element **154** which may be selectively extended and selectively activated to treat tissue. FIGS. 5A-5C show an alternate embodiment of the present disclosure which shows that the knife **185** maybe extended from the distal end of the end effector assembly **100** and selectively energized to treat tissue in a monopolar fashion. FIG. 6A shows another embodiment wherein the bottom jaw member **120'** extends distally from the top jaw member **110'** to allow the surgeon to selectively energize the bottom jaw member **120'** and treat tissue in a monopolar fashion. FIG. 6B shows yet another embodiment wherein the jaw members **110"** and **120"** include tapered distal ends which are

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selectively energized with a single electrical potential to treat tissue in a monopolar fashion.

FIGS. 1A-1D and 2-4 show one embodiment wherein a monopolar element **154** is housed for selective extension within one jaw member, e.g., jaw member **120**, of the end effector assembly **100**. More particularly, monopolar element **154** is designed to move independently from knife assembly **180** and may be extended by further proximal movement of the trigger assembly **70** (FIGS. 1A, 2 and 3) or by a separate actuator **450** (FIG. 4).

Preferably, the monopolar element **154** is connected to a reciprocating rod **65** which extends through an elongated notch **13** in the outer periphery of the shaft **12** as best seen in FIG. 1B. Drive rod **60** which actuates the knife **185** extends through the inner periphery of shaft **12**. In order to extend the monopolar element **154**, the jaw members **110** and **120** are initially closed and the knife **185** is advanced distally utilizing the trigger assembly **70** (See FIG. 2). As best shown in FIG. 1C, the trigger **71** is initially advanced to translate the knife **185** distally to cut through tissue, i.e., the "cut" stage (shown in phantom). Thereafter and as shown in FIG. 3, the trigger **71** may be further actuated in a proximal direction to extend the monopolar element **154**, i.e., the "extend" stage (shown in phantom).

It is envisioned that the trigger assembly **70** may be designed such that the monopolar element **154** may be extended when the jaw members **110** and **120** are in the open position. For example, the trigger **71** may be moved distally (or upwardly) from its original, rested, neutral or pre-actuated position to advance the monopolar element **154**. Alternatively, the monopolar element **154** may be advanced irrespective of the orientation of the jaw members **110** and **120**. For example, the trigger assembly **70** could be designed such that the it can be moved laterally (i.e., perpendicular to the longitudinal axis "A") to advance the monopolar element **154** or the trigger assembly **70** could be designed such that the monopolar element **154** is extendible when the trigger **71** is moved to a proximal-most position (i.e., past the "cut" position as described above) and/or when the trigger **71** is advanced distally from the neutral or pre-actuated orientation. A return spring (not shown) may be included to return the monopolar element **154** to a non-extended position upon release of the trigger **71**.

Upon extension of the monopolar element **154**, the generator **300** is preferably configured to automatically switch the forceps **10** from a bipolar activation mode (i.e., deactivating energy delivery to jaw members **110** and **120**) to a monopolar activation mode (i.e., activating the monopolar element **154**). As can be appreciated, the forceps **10** may also (or alternatively) be configured for manual switching between the bipolar activation mode and the monopolar activation mode.

As described above, when the forceps **10** is configured for bipolar operation, the activation of switch **200** transfers energy from jaw member **110** through the tissue and to jaw member **120** to treat tissue. In the monopolar mode, activation of switch **200** (or a separate switch, e.g., a footswitch), transfers energy to the monopolar element **154**, through the tissue and to a return electrode **550**, e.g., a return pad, placed adjacent to or in contact with the patient. The monopolar activation mode allows the monopolar element **154** to quickly treat avascular tissue structures and/or quickly dissect narrow tissue planes.

As can be appreciated, it is also envisioned that the trigger assembly **70** may be electrically configured to transmit electrical energy to the monopolar element **154** when extended. For example, the trigger assembly **70** may be

configured such that proximal-most actuation of the trigger 71 (FIG. 1C) both extends and activates the monopolar element 154. An automatic safety circuit 460 (or mechanical safety lock (not shown)) may be employed which prevents the switch 200 from energizing the jaw members 110 and 120 when the monopolar element 154 is extended.

FIG. 4 shows another embodiment of the present disclosure wherein the monopolar element 154 is selectively extendible utilizing a second actuator 450. As described above, the knife 185 is advanced by actuating the trigger 71 in a generally proximal direction. The monopolar element 154 is selectively advanceable independently of the knife 185 and may be extended when the jaw members 110 and 120 are disposed in either the open configuration or closed configuration. It is envisioned that the actuator 450 may be electrically configured to activate the monopolar element 154 automatically once extended or manually by activation switch 200 or perhaps another switch (not shown). As mentioned above, a safety circuit 460 may be employed to deactivate jaw members 110 and 120 when the monopolar element 154 is extended such that activation of the switch 200 energizes the monopolar element 154. In the case of a separate activation switch for the monopolar element, the safety circuit would deactivate the switch 200.

FIG. 5A-5C show an alternate embodiment of the present disclosure wherein the knife 185 can be extended distally beyond the jaw members 110 and 120 and separately energized to treat tissue. In this instance, when the knife is extended beyond the jaw members 110 and 120, the knife 185 becomes the monopolar element.

For example and as depicted in the activation sequence shown in FIGS. 5A-5C, the knife 185 is initially seated in a neutral position during tissue approximation and grasping and during the sealing process. Once the jaw members 110 and 120 are closed about tissue, the elongated knife channel 115 (defined by upper and lower knife channels 115a and 115b, respectively) is formed to allow selective translation of the knife 185 through tissue disposed between the jaw members 110 and 120. Upon actuation of the trigger 71, the knife bar 64 forces the knife 185 distally through the tissue to the distal end of the knife channel 115. A stop 119 is included to temporarily limit the movement of the knife 185 and provide the user with positive tactile feedback as to the end of the cutting stroke. Upon further actuation of the trigger 71, the knife 185 overcomes the limiting forces associated with the stop 119 and is forced by the knife bar to further extend out of the knife channel 115 and beyond the distal ends of the jaw members 110 and 120.

It is envisioned that once the knife 185 extends beyond the jaw members 110 and 120, a safety or switch deactivates energizing circuitry to the jaw members 110 and 120 and activates the energizing circuitry to the knife 185 such that activation of the switch 200 energizes the knife 185 and the jaw members remain neutral. For example, the stop 119 may act as a safety switch such that upon being forced by the knife 185 out of or away from the knife channel 115, the stop 119 deactivates circuitry to the jaw members 110 and 120 and activates circuitry to the monopolar knife 185 and the return electrode 550. A separate lead 69 may be used to electrically communicate with the generator 300. As can be appreciated, the knife 185 may now be used in a monopolar fashion to treat tissue.

Upon release of the trigger 71, the knife 185 automatically retracts into the knife channel 115 and back to the pre-actuated position as shown in FIG. 5A. At the same time the stop 119 reverts to its original position to temporarily block the knife channel 115 for subsequent actuation.

FIG. 6A shows another embodiment of a forceps 10' according to the present disclosure wherein the lower jaw member 120' is designed to extend beyond the distal end of jaw member 110'. In order to switch from a bipolar mode of the operation to a monopolar mode, the surgeon activates a switch or control which energizes jaw member 120' to a first potential and activates a return pad 550 to a second potential. Energy is transferred from jaw member 120, through tissue, and to the return pad 550 to treat tissue. The distal end of jaw member 120' acts as the monopolar element for treating the tissue and may be shaped accordingly to enhance electro-surgical effect.

FIG. 6B shows yet another schematic embodiment of a forceps 10'' according to the present disclosure wherein the distal ends of both jaw members 110 and 120 are shaped to treat tissue when disposed in a monopolar mode. More particularly, the distal tips 112a'' and 122a'' are preferably elongated or tapered to enhance energy delivery when the forceps 10'' is disposed in the monopolar mode. When disposed in the bipolar mode, the tapered ends 112a'' and 122a'' do not effect treating tissue between electrically conductive plates 112'' and 122''.

A control switch 500 is preferably included which regulates the transition between bipolar mode and monopolar mode. Control switch 500 is connected to generator 300 via cables 360 and 370. A series of leads 510, 520 and 530 are connected to the jaw members 110, 120 and the return electrode 550, respectively. As best shown in the table depicted in FIG. 6C, each lead 510, 520, and 530 is provided with an electrical potential or remains neutral depending upon the particular "mode" of the forceps 10''. For example, in the bipolar mode, lead 510 (and, in turn, jaw member 110'') is energized with a first electrical potential and lead 520 (and, in turn, jaw member 120'') is energized with second electrical potential. As a result thereof, electro-surgical energy is transferred from jaw member 110'' through the tissue and to jaw member 120''. The return electrode 550 remains off or neutral.

In a monopolar mode, jaw member 110'' and 120'' are both energized with the same electrical potential and the return pad 550 is energized with a second electrical potential forcing the electrical current to travel from the jaw members 110'' and 120'', through the tissue and to the return electrode 550. This enables the jaw members 110'' and 120'' to treat tissue in a monopolar fashion which, as mentioned above, advantageously treats avascular tissue structures and/or allows quick dissection of narrow tissue planes. As can be appreciated, all of the leads 510, 520 and 530 may be deactivated when the forceps 10'' is turned off or idle.

Although the general operating components and inter-cooperating relationships among these components have been generally described with respect to a vessel sealing forceps 10, other instruments may also be utilized which can be configured to allow a surgeon to selectively treat tissue in both a bipolar and monopolar fashion. For example, bipolar grasping and coagulating instruments, cauterizing instruments, bipolar scissors, etc.

The present disclosure also relates to a method for treating tissue with electro-surgical energy from the electro-surgical generator 300 which includes the steps of: providing an endoscopic forceps 10 including a housing 20 having a shaft 12 affixed thereto. The shaft 12 includes first and second jaw members, 110 and 120, respectively, attached to a distal end of the shaft 12. An actuator or handle assembly 30 is included for moving jaw members 110 and 120 relative to one another from a first position wherein the jaw members 110 and 120 are disposed in spaced relation relative to one

another to a second position wherein the jaw members **110** and **120** cooperate to grasp tissue therebetween. A monopolar element **154** is also included which is housed within at least the first jaw member **120** and selectively movable from a first position within the first jaw member **120** to a second position distal to the first jaw member **120**. A return electrode **550** is provided and placed in contact with patient tissue.

The method also includes the steps of: connecting to each jaw member **110** and **120**, the monopolar element **154** and the return electrode **550** to the electrosurgical generator **300**; grasping tissue between the jaw members **110** and **120**; selectively activating the jaw members **110** and **120** to treat tissue disposed between the jaw members **110** and **120** in a bipolar fashion; and selectively activating the monopolar element **154** and the return electrode **550** independent of the jaw members **110** and **120** to treat tissue in a monopolar fashion.

Preferably, after the step of selectively activating the jaw members **110** and **120** to treat tissue, the method includes the step of: extending the monopolar element **154** from the distal end of the jaw members **110** and **120**. Advantageously, the step of selectively activating the monopolar element **154** includes deactivating the jaw members **110** and **120**.

After the step of selectively activating the jaw members **110** and **120** to treat tissue, the method may include the step of: releasing the tissue from the jaw members **110** and **120**.

From the foregoing and with reference to the various figure drawings, those skilled in the art will appreciate that certain modifications can also be made to the present disclosure without departing from the scope of the same. For example, it may be preferable to add other features to the forceps **10**, e.g., an articulating assembly to axially displace the end effector assembly **100** relative to the elongated shaft **12**.

It is envisioned that the forceps **10** may be designed such that it is fully or partially disposable depending upon a particular purpose or to achieve a particular result. For example, end effector assembly **100** may be selectively and releasably engageable with the distal end **16** of the shaft **12** and/or the proximal end **14** of shaft **12** may be selectively and releasably engageable with the housing **20** and the handle assembly **30**. In either of these two instances, the forceps **10** would be considered "partially disposable" or "reposable", i.e., a new or different end effector assembly **100** (or end effector assembly **100** and shaft **12**) selectively replaces the old end effector assembly **100** as needed. As can be appreciated, the presently disclosed electrical connections would have to be altered to modify the instrument to a reposable forceps.

Moreover, it is envisioned that the switch **200** may be decommissioned during the cutting process. Decommissioning the switch **200** when the trigger **71** is actuated eliminates unintentionally activating the forceps during the cutting process. It is also envisioned that the switch **200** may be disposed on another part of the forceps **10**, e.g., the fixed handle **40**, rotating assembly **80**, housing **20**, etc.

While several embodiments of the disclosure have been shown in the drawings, it is not intended that the disclosure be limited thereto, as it is intended that the disclosure be as broad in scope as the art will allow and that the specification be read likewise. Therefore, the above description should not be construed as limiting, but merely as exemplifications of preferred embodiments. Those skilled in the art will envision other modifications within the scope and spirit of the claims appended hereto.

What is claimed is:

1. An endoscopic forceps, comprising:

a housing having a shaft affixed thereto, the shaft including first and second jaw members attached to a distal end thereof;

an actuator for moving jaw members relative to one another from a first position wherein the jaw members are disposed in spaced relation relative to one another to a second position wherein the jaw members cooperate to grasp tissue therebetween;

a source of electrosurgical energy connected to each jaw member such that the jaw members are selectively capable of operating in a bipolar mode which enables the jaw members to conduct bipolar energy through tissue held therebetween to treat tissue; and

a monopolar element housed within at least the first jaw member and selectively movable from a first position within the first jaw member to a second position distal to the first jaw member, the monopolar element being connected to the source of electrosurgical energy and being selectively activateable independent of the jaw members.

2. An endoscopic forceps according to claim 1 wherein the monopolar element includes a sharpened cutting edge.

3. An endoscopic forceps according to claim 1 wherein the forceps includes a knife which is selectively moveable within a knife channel defined within at least one of the first and second jaw members to cut tissue disposed between the first and second jaw members.

4. An endoscopic forceps according to claim 1 wherein the forceps is a vessel sealing forceps and at least one of the jaw members includes at least one non-conductive stop member disposed thereon which controls the distance between the first and second jaw members when tissue is held therebetween.

5. An endoscopic forceps according to claim 1 wherein the monopolar element is a knife which is selectively moveable within a knife channel defined within at least one of the first and second jaw members to initially cut tissue disposed between the first and second jaw members and subsequently extend distally from the jaw members, the knife being energized to treat tissue in a monopolar fashion.

6. An endoscopic forceps according to claim 5 wherein the knife includes a safety which only allows electrical activation of the knife when the knife is extended from the distal ends of the jaw members.

7. An endoscopic forceps according to claim 3 further comprising a trigger operable to both move the knife to divide tissue disposed between the jaw members and to extend the monopolar element from the first position within the first jaw member to the second position distal to the first jaw member.

8. An endoscopic forceps according to claim 1 wherein the actuator operates to both move the jaw members relative to one another from the first to second positions to grasp tissue therebetween and the actuator operates to extend the monopolar element from the first position within the first jaw member to the second position distal to the first jaw member.

9. An endoscopic forceps according to claim 1 further comprising a second actuator which operates to extend the monopolar element from the first position within the first jaw member to the second position distal to the first jaw member.

10. A method for treating tissue with electrosurgical energy from an electrosurgical generator, the method comprising the steps of:

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providing an endoscopic forceps comprising:

a housing having a shaft affixed thereto, the shaft including first and second jaw members attached to a distal end thereof;
 an actuator for moving jaw members relative to one another from a first position wherein the jaw members are disposed in spaced relation relative to one another to a second position wherein the jaw members cooperate to grasp tissue therebetween;
 a monopolar element housed within at least the first jaw member and selectively movable from a first position within the first jaw member to a second position distal to the first jaw member; and
 a return electrode placed in contact with patient tissue; connecting each jaw member, the monopolar element and the return electrode to the electrosurgical generator;
 grasping tissue between the jaw members;
 selectively activating the jaw members to treat tissue disposed between the jaw members in a bipolar fashion; and

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selectively activating the monopolar element and the return electrode independent of the jaw members to treat tissue in a monopolar fashion.

11. A method according to claim **10** wherein after the step of selectively activating the jaw members to treat tissue, the method includes the step of:

extending the monopolar element from the distal end of the jaw members.

12. A method according to claim **10** wherein the step of selectively activating the monopolar element includes deactivating the jaw members.

13. A method according to claim **10** wherein after the step of selectively activating the jaw members to treat tissue, the method includes the step of:

releasing the tissue from the jaw members.

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